REMARKS

Reconsideration of the outstanding Office Action is respectfully solicited.

[1] Applicants traverse and respectfully request withdrawal of the rejection of Claim 1 under 35 U.S.C. 112; the Examiner has indicated and required that:

> *(i) Claims 1-5 are rejected under 35 U.S.C 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.*
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> *Claim 1, line 1, "a shaft sealing apparatus", how can a shaft sealing apparatus have a vacuum chamber and a drive shaft.*

It is believed the rejection is moot in view of the amendment of Claim 1, in response to the Examiner's indication and suggestion. The amendment to the claim 1 is based on the original claim 6, lines 19-23 on page 9, lines 14-19 on page 10 lines 24-33 on page 21 and Figs. 1 and 2 and so on.

The present invention is defined in the amended claim 1 as follows:

A shaft sealing apparatus, comprising:

(f1) a vacuum casing formed therein with a vacuum chamber, said vacuum casing having a base portion formed with an opening wherein said opening provides communication between said vacuum chamber and the atmosphere;

(f2) a driving shaft having an outer cylindrical surface and movably extending in said vacuum chamber of said vacuum casing through said opening of said vacuum casing; and

(f3) a sealing ring in the form of an annular ring shape, received in said opening of said vacuum chamber and including a sealing lip held in contact with said outer cylindrical surface of said driving shaft and formed with an annular groove , an annular spring member received in said annular groove of said sealing lip and operative to impart a force to said sealing lip to ensure that said sealing lip is held in tight contact with said outer cylindrical surface of said driving shaft, and a peripheral portion radially outwardly extending from said sealing lip and fixedly connected with said base portion of said vacuum casing,

(f4) in which said outer cylindrical surface of said driving shaft is smaller in surface roughness Ra than 0.1 (μm).

[2] In the above Office Action, the Examiner also has indicated that:

> *(ii) Claims 1 and 3 are rejected under 35 U.S.C 103(a) as being unpatentable over Takebayashi et al.(US.6,676,132) in view of DeHart et al.(US. 4,573,690).*
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> *Takebayashi discloses a combination of a vacuum casing (casing 2, where B is under vacuum) formed with a vacuum chamber (where pressure in region B). A drive shaft (1) having an outer cylindrical surface and movably extending in the vacuum chamber of the vacuum casing. The seal assembly having a sealing ring in the form of an annular ring and including a sealing lip (6a) held in contact with the outer cylindrical surface of the driving shaft and formed with an annular groove (groove where spring 8 lies). The sealing assembly having an annular spring member 88) received in the groove to impart a force (function of a spring) to sealing lip to ensure that the sealing lip is held in tight contact with the cylindrical surface of the drive shaft.*
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> *The annular spring member of the sealing ring is made of metal wire in the form of a helical shape and is of a circular cross-section taken on the plane perpendicular to the center axis passing therethrough(garter spring 8 has this form).*
>
> *Takebayashi discloses the invention substantially as claimed above but fails to disclose the outer cylindrical surface of the drive shaft is smaller in the surface roughness Ra than 0.1 micrometer. DeHart discloses a shaft surface (pads 30 on shaft) that is in contact with a sealing lip and the shaft surface is smaller in roughness than Ra of 0.1 micrometer (column 4, line 63). It would have been obvious to one ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface to have a surface roughness that is smaller in surface roughness Ra than 0.1 micrometer as taught by DeHart, to provide an improved sealing surface (see abstract of DeHart) and to reduce seal friction (column 2, lines 5 - 8 of DeHart).*

Applicants respectfully traverse the rejection. The applicants believe that they are entitled to the priority of JAPAN 2000-324831 application filed October 25, 2000 and made a claim of priority, under 35 U.S.C. 119, based on that application and on a second application JAPAN 2001-291877, filed September 25, 2001; the claim for priority was filed in the U.S. Patent Office on December 10, 2001.

The priority date of JAPAN 2000-324831 predates the presumptive date, under §371(c)(1), (2), (4), i.e., the §102(e) date of Takebayashi et al. patent. That is, in

applicants' view, the Takebayashi et al patent is after the filing date of JAPAN 2000-324831 previously regularly filed by the applicants in Japan. Accordingly, it is believed that a rejection under U.S.C 103(a), based on Takebayashi is improper and should be withdrawn.

Regarding DeHart, the Examiner has indicated that DeHart discloses a shaft surface 12 (pads 30 on shaft) that is in contact with a sealing lip and smaller in roughness than Ra of 0.1 micrometer (column 4, line 63).

The shaft surface 12 taught by DeHart is, however, far from that smaller in roughness than Ra of 0.1 micrometer because of the fact that the shaft surface 12 is formed with a plurality of indentations 28 which are uniformly spaced along the path of relative motion between the seal lip 26 and the sealing surface 12(column 4, lines 19-26) and each of which has a width Iw approximately 0.263 mm and a depth approximately 0.025 mm despite that only the pads 30 are smaller in roughness than Ra of 0.1 micrometer. The reference to DeHart, therefore, does not teach the above essential feature (f4) of the present invention. And, it is apparent that DeHart fails to suggest the above essential feature (f1) to (f3) of the present invention.

In addition, the gap between the sealing lip 26 and the sealing surface 12 of the shaft is far exceeding in volume in comparison with the gap between the sealing lip and the driving shaft of the claimed invention because of the existence of the plurality of indentations 28 spaced along the path of the relative motion between the seal lip 26 and the sealing surface 12. This significantly lessens the sealability of the seal 20 taught by DeHart during the relative motion between the seal lip 26 and the sealing surface 12 in the case the seal surface is employed to seal the gap between the highly vacuumed chamber and the atmosphere. Furthermore, the sealing lip 26 held in pressing contact only with the pads 30 is liable to be elastically deformed due to the existence of the plurality of indentations 28 spaced along the path of the relative motion between the seal lip 26 and the sealing surface 12. In other words, the sealing lip 26 is inevitably creeped in case of long time non-operation condition under which the sealing lip 26 and the shaft 10 are not relatively moved. It is therefore impossible for the sealing apparatus taught by DeHart to effectively seal the gap around the driving shaft between the highly vacuumed chamber

and the atmosphere.

In contrast, the sealing apparatus according to the claimed invention makes it possible to effectively seal the gap around the driving shaft between the highly vacuumed chamber and the atmosphere under the state that the driving shaft is movably extending in the vacuum chamber through the opening of the vacuum casing.

Accordingly, it would not have been obvious to one ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface to have a surface roughness that is smaller in surface roughness Ra than 0.1 micrometer.

The combination of the seal taught by Takebayashi and the shaft surface taught by DeHart as indicated by the Examiner is therefore nothing but the hindsight.

[3] The Examiner has further indicated that:

> *(iii) Claim 2 is rejected under U.S.C 103(a) as being unpatentable over Takebayashi and DeHart as applied to claim 1 above, and further in view of Aihara (US. 5,853,502).*
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> *Takebayashi and DeHart disclose the invention substantially as claimed above but fails to disclose the outer cylindrical surface of the shaft to have hardness larger than Hv 650. Aihara teaches to have a shaft to have a cylindrical surface that has hardness larger than Hv 650. It would have been obvious to one ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface of the shaft of Takebayashi and DeHart to have hardness larger than Hv 650, to provide better strength and excellent hardness as required by a particular environment(see Aihara).*

The remarks concerning Takebayashi and DeHart, set forth above, are relied upon in the traversal of this rejection and for the purposed of brevity are not reiterated. The reference to Aihara discloses a constant velocity universal joint for the drive shaft of the automobile. However, Aihara teaches "*if the surface hardness of parts after carburizing and quenching is lower than Hv 650, resistance against rolling contact fatigue deteriorates. Therefore, for high strength joint parts which are used under higher surface pressure as compared to conventional situations, resistance against rolling contact is insufficient. For the reasons described above, the surface hardness of the parts of the constant velocity universal joints for drive shaft is determined between Hv 650 and Hv 800 inclusive(column 10, lines 46-54)*", "*the roughness of the rolling surface greatly affects*

the service life of the ball case(column 6, lines 48-49)" and *"the above drawbacks are eliminated by selecting the proper degree of working during cold drawing as well as proper annealing condition(column 6, lines 62-64)".*

This means that Aihara only teaches a proper surface hardness of the inner race of the universal joint obtained to have resistance against rolling contact between the inner race 4 and balls 5 by selecting the proper degree of working during the cold-drawing as well as proper annealing conditions. Such the rolling contact between the inner race and the metal balls in the universal joint ordinarily requires a surface hardness extremely higher than the shaft surface held in sliding contact with the sealing lip of the sealing ring. Aihara, therefore, neither teaches nor suggests a specific environment leading to a motivation to provide better strength and excellent hardness of the shaft surface held in sliding contact with the sealing lip.

According to the present invention, on the other hand, the combination of the outer cylindrical surface of the driving shaft smaller in surface roughness Ra than 0.1 μm and larger in Vickers hardness Hv than 650 makes it possible for a long time to be excellent in characteristic to seal the gaps between the driving shaft and other parts around the driving shaft within a severe tolerance (less than 1×10^{-9} Pa m^3/s). (See lines 18-23 on page 17 of the specification)

As a consequence, it would not have been obvious to one ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface of the shaft of Takebayashi and DeHart to have hardness larger than Hv 650.

The combination of the seal taught by Takebayashi and the shaft surface taught by DeHart and Aihara as indicated by the Examiner is therefore nothing but the hindsight.

[4] The Examiner has yet further indicated that:

> *(iv) Claim 5 is rejected under U.S.C 103(a) as being unpatentable over Takebayashi and DeHart as applied to claim 1 above, and further in view of Reinsma (US. 4,331,339).*
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> *Takebayashi and DeHart disclose the invention substantially as claimed above but fail to disclose the sealing lip of the sealing ring is made of synthetic resin constituted by an ultra high molecular weight compound. Reinsma teaches to have a seal made from synthetic resin constituted by an ultra high molecular*

weight compound (column 4, lines 1-10). It would have been obvious one ordinary skill in the art at the time the invention was made to configure the sealing lip of Takebayashi and DeHart to be formed of a synthetic resin constituted by an ultra high molecular weight compound as taught by Reinsma, to prove stronger lip seal (abstract of Reinsma).

Applicants respectfully traverse the grounds of rejection. The remarks concerning Takebayashi and DeHart, set forth above, are relied upon in the traversal of this rejection and for the purposed of brevity are not reiterated. The reference to Reinsma discloses an end face seal assembly provided with an earthmoving vehicle or the like used in severe service environments. The seal assembly includes an annular thrust sealing member 36 to exclude external contaminants from a joint 12 between relatively movable members 14, 22.

The thrust sealing member 36 is made from a thermoplastic resin selected from the group consisting of a polyamide polymer and an ultra-high molecular weight polyethylene, and is received in the outer link 14 to be held in sealing engagement with the end face of the bushing 22 having the track pin 20 received therein.

Reinsma, however, fails to teach any one of a sealing ring received in the opening of the vacuum chamber, a sealing lip held in contact with the outer cylindrical surface of the driving shaft, an annular spring member operative to impart a force to the sealing lip to ensure that the sealing lip is held in tight contact with the outer cylindrical surface of the driving shaft, and a peripheral portion radially outwardly extending from the sealing lip and fixedly connected with said base portion of said vacuum casing.

As aforesaid, it would not have been obvious to one ordinary skill in the art at the time the invention was made to configure the outer cylindrical surface to have a surface roughness that is smaller in surface roughness Ra than 0.1 micrometer.

And, according to the invention defined in Claim 5, the combination of the sealing ring defined in claim 5 and the outer cylindrical surface defined in claim 1 makes it possible to be excellent in characteristic to seal the gaps between the driving shaft and other parts around the driving shaft within a severe tolerance (less than 1×10^{-9} Pa m^3/s). The flow of leakage gas can be substantially checked between the highly vacuumed chamber and the atmosphere around the driving shaft. This effect cannot be obtained by merely using an ultra-high molecular sealing lip with the conventional shaft surface larger

in surface roughness Ra than 0.1 micrometer or the shaft surface taught by DeHart.

Therefore, it would not have been obvious to one ordinary skill in the art at the time the invention was made to configure an ultra-high molecular sealing lip held in contact with the outer cylindrical surface of the driving shaft smaller in surface roughness Ra than 0.1 micrometer.

[5] Accordingly, it is believed that claim 1 is patentably distinguishable over the prior art of record and therefore in condition for allowance. The claims 2, 3 and 5 each dependent upon claim 1 are independently believed to be allowable.

Reconsideration and an early allowance are respectfully requested.

Respectfully submitted,

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Marina V. Schneller (Reg. No. 26,032)
Venable LLP
P.O. Box 34385
Washington, D.C. 20004-9998
Tel.: (202) 344-4062
Telefax: (202) 344-8300